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PRELIMINARY NOTES ON THE VALUE OF WINTER PROTECTION FOR BEES[1]

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That a strong colony of bees will gather more honey than a weak one is a fact accepted by all experienced beekeepers. However, to gather more honey, this colony should be strong at the proper time in order to take the fullest advantage of the honey-flow. The proper time to have a colony strong is at the beginning of the honey-flow. If it becomes strong too early, it consumes stores which the bees have in the hive; if too late, it cannot assist in gathering the crop for that season. Whether or not the colony is strong will depend to a large extent upon how it passed through the winter.

Gates, 1914, gives some very valuable data on the temperature of the colony of bees throughout the year. Phillips and Demuth, 1914, give the results of some very careful observations on the temperature of a colony of bees in winter, and further explain in detail the actions of such a colony during the winter which are necessary in order to maintain a proper temperature. Phillips maintains that a bee may be compared to a storage battery in that it has a certain amount of energy to spend, after which it dies. He further says that the bee is

[1] Contribution No. 48 from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project No. 126 of the Agricultural Experiment Station.

obliged to resort to muscular activities in order to maintain the proper hive temperature. A system of winter protection which would minimize this expenditure of energy would result in a strong colony in the spring.

Phillips and Demuth, 1915 and 1918, give directions for preparing bees for the winter which will aid very materially in securing a strong colony of bees at the right time of the year. Although their explanations as to the need of winter protection for bees, and how to secure this should be satisfactory to all, there still remain a large number of people who either through mistaken observations of their own, prejudice, or on account of giving value to mistaken observations of others, will persist in refusing to accept even the clearest explanation if it does not happen to coincide with their preconceived opinions. This latter class of people are prone to maintain that these explanations may perhaps be facts, but they apply to some other part of the country than the one in which they reside. In order to convince them that these facts apply to their locality as well as to all other localities, and that these problems apply in every respect to them as much as to other beekeepers, it is often necessary to conduct additional experiments to prove further something which has been clearly explained before.

It has been the purpose of this experiment to gather data along the following points:

First, the comparative value of one-story and two-story hives for wintering; second, the importance of a windbreak; third, the comparative value of packed and unpacked hives for wintering; fourth, the amount of stores needed to last a colony until the honey-flow commences; fifth, the effect of climatic conditions on wintering; sixth, to ascertain what form of winter protection will insure the strongest colony of bees at the beginning of the honey-flow.

In order to secure data on these points, experiments have been carried on at the Kansas State Agricultural College since 1917. In the experiment, two sets of hives are used. One set is placed in an open exposed situation where it receives no protection at all from the prevailing winds, and the other set is placed in a very dense hedge windbreak, so that the strength of the wind is very materially broken before it reaches the hives. In each set there are three colonies of bees corresponding in every way with each other. That is, there is one one-story hive, one two-story hive, and one packed hive in each set. The packed hive is in a single packing case, with four inches of leaves beneath it, six inches around it, and eight inches on top, used as an insulation. The entrances during the winter months are contracted to one three-eighths of an inch auger hole. Each one of these six hives rests on a platform scale, and is not removed from its position throughout

the year. Daily readings are taken throughout the year of the weights of the various hives, and all changes in weight recorded each day. In order to determine the amount of honey that is in each hive, and the number of bees present, a general weighing of the colonies is made in the fall on the date that the bees are put into winter quarters. On the day that the honey-flow starts, another general weighing is made, to determine the number of bees which have passed through the winter and results of both the spring and the fall weighing are compared to secure the data desired. Briefly, the method of weighing is as follows:

Each colony is weighed early in the morning before any of the bees emerge. Next the weight of the hives without the frames is ascertained, and the weight of the frames with honey. From the weight of the frames of honey is deducted the weight of the empty frames, giving the amount of honey which is in the colony. We then know the weight of the hive, and also the combined weight of the hive and honey. This total, when subtracted from the weight of the hive, honey, and bees, gives the weight of the bees. Precautions are taken in recording these weights to prevent the bees from filling up with honey, thus making, according to the figures, a larger number of bees and smaller amount of honey than really exists in the hive. The process of weighing these colonies is rather complicated, usually requiring from three to four persons a whole day in order to weigh the six colonies in the experiment.

The number of bees in a pound has been variously estimated, but for the purpose of this experiment we assume that there are 5,000 bees in every pound. If this number is adhered to throughout the experiment, it will be as fair to one colony as to another. As stated above, the weight is recorded each day from each one of these hives throughout the year. In addition to these, the record of the temperature, the direction of the wind, and the strength of the wind for each day is also recorded in order that we may have an opportunity to learn what effect climatic changes have on the wintering of the bees. These colonies are brought as nearly as possible up to the same strength in bees and honey. The queens used in them are all from the same stock, purchased from a reliable queen breeder, and introduced into the colonies on the same day. Each colony is requeened during the month of August in order to insure a young queen to carry on the duty of the hive. The weighing which is conducted in the spring shows whether or not there has been an increase in the number of bees during the winter. It is considered that the form of wintering which produces the largest number of bees in the hive on the day that the honey-flow starts is the most successful method of wintering.

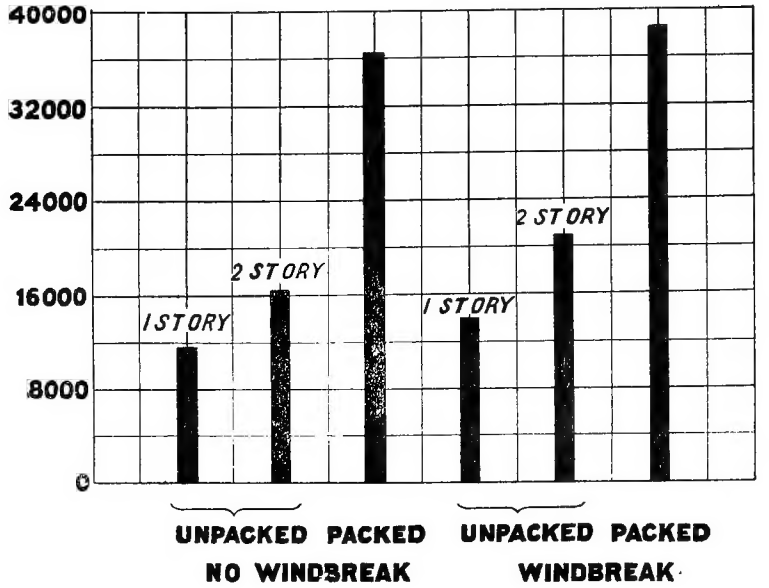

Fig. 1. Showing the number of bees at the beginning of the honey-flow, the advantage of packed over unpacked hives, and the value of sheltering with a windbreak.

TABLE I. NUMBER OF BEES AND FRAMES OF BROOD IN EACH COLONY MAY 4, 1919

	Unsheltered—No Windbreak	
One-story	Two-story	Packed
11,718—3 2/3 frames	16,406—3 1/2 frames	36,718—4 1/2 frames
	Sheltered—Windbreak	
One-story	Two-story	Packed
14,063—4 1/2 frames	20,936—3 3/4 frames	38,594—5 3/4 frames

COMPARATIVE VALUE OF ONE-STORY AND TWO-STORY HIVES

At first glance it would seem that bees would winter better in a one-story hive than they would in a two-story hive, since there is less space to keep warm, and consequently, they would not use as much energy as they would in a two-story hive. If the winter stores are properly arranged so that the bees will be in the upper hive body during the coldest part of the winter, the objection of extra room to be kept warm is largely overcome. Two of the requirements for good wintering, according to Phillips and Demuth, 1915, are, first, plenty of stores, and second, plenty of room for brood rearing. A two-story hive suits these conditions much better than a one-story hive would do.

Table I shows that in the spring the two-story hive in the open had 16,406 bees, while the one-story hive had only 11,718, or a difference of 5,688 bees. In the windbreak, the two-story hive had 20,936 bees and the one-story hive had 14,063, or a difference of 6,873 bees. This

shows not only the superiority of the two-story hive over the one-story, but also shows that the windbreak made a difference of 1,185 bees.

TABLE II. COMPARISON BETWEEN NUMBER OF BEES IN FALL AND SPRING WEIGHINGS

	1917–18	1918–19
No Windbreak		
One-story	−332	−3,282
Two-story	2,808	−469
Packed	4,576	22,968
Windbreak		
One-story	4,538	313
Two-story	13,346	5,936
Packed	15,132	24,844

In 1917, the average daily consumption of honey for the six hives, over a period of 139 days, was one eighth of a pound.

In 1918, the average daily consumption of honey for the six hives, over a period of 150 days, was one eighth of a pound.

Table II shows that in the winter of 1917–18, while the one-story hive in the open lost 332 bees during the winter, the two-story hive similarly placed gained 2,208 bees. With those bees protected by the windbreak the two-story hive gained 13,346, while the one-story hive gained only 4,538. During the winter of 1918–19 the one-story hive in the open lost 3,282 bees, while the two-story hive only lost 469. In the windbreak the two-story hive gained 5,936, while the one-story hive gained only 313.

If the number of bees at the beginning of the honey-flow be a proper standard, these results plainly indicate the superiority of the two-story hive. The same factors which make this possible ought to make the deeper and larger hives superior even to the two-story hive, since the latter will have plenty of room for stores and ample room for spring brood rearing without too large a space for the bees to keep warm.

COMPARATIVE VALUE OF A WINDBREAK

A study of Table I would indicate the value of a windbreak, especially to colonies which are not otherwise protected. In the case of the one-story hive, there were 2,345 more bees in the hive protected by a windbreak than in the unprotected one-story hive. The protected two-story hive had 4,530 more bees than the unprotected two-story hive. While the protected packed hive only had 1,776 more bees than the unprotected packed hive, thus indicating that although a windbreak is very valuable, yet if it is not possible to provide one the loss may be partially overcome by using sufficient packing. The figures shown in Table II also indicate very clearly the value of a windbreak. In 1917–18 the one-story hive lost 332 bees during the winter, while the one-story hive in the sheltered position gained 4,538. During the next winter, the same hives respectively lost 3,282 and gained 313. The two-story hive shows the value of a windbreak more clearly even

than the one-story, because while the two-story unsheltered hive gained 2,808 in 1917–18, the sheltered hive gained 13,346. In 1918–

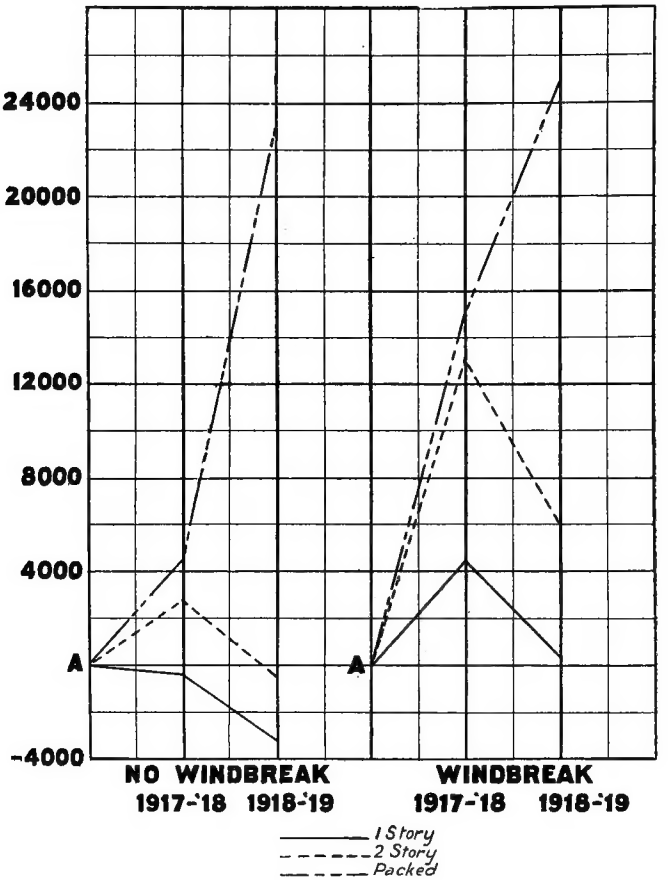

Fig. 2. Showing the gain or loss in the number of bees between the fall and spring weighings, demonstrating the value of both packing and windbreak.

19 the first hive lost 469 while the second gained 5,936. Judged by the standard already adopted, the windbreak is shown to be very valuable as a factor of winter protection.

Comparative Value of Packed and Unpacked Hives for Winter

During the winter of 1917–18, the packed hives were insulated with shavings and excelsior for packing material, but it was not as good as the forest-tree leaves which were used in 1918–19, and which will be used in the future.

Table I shows that the packed hive had 25,000 more bees than the one-story unpacked hive. This represents about five pounds of bees, which, at their present market value of around $2 a pound, would mean about $10. The difference between the number of bees in a packed hive and in an unpacked one in the sheltered set of hives was practically the same as in the open.

Table II, which gives the results for 1918–19, shows that the winter of 1918–19 was harder on the bees than was the preceding winter, and yet this is the winter in which packed bees wintered the best. In fact, there is more difference in this unfavorable winter between the packed and unpacked hives than in the more favorable one. This is shown by the fact that while the one-story hive in the open lost 3,282 bees, and the two-story hive 469, the packed hive gained 22,968. In the sheltered hives the one-story hive gained 313 bees, the two-story hive gained 593,

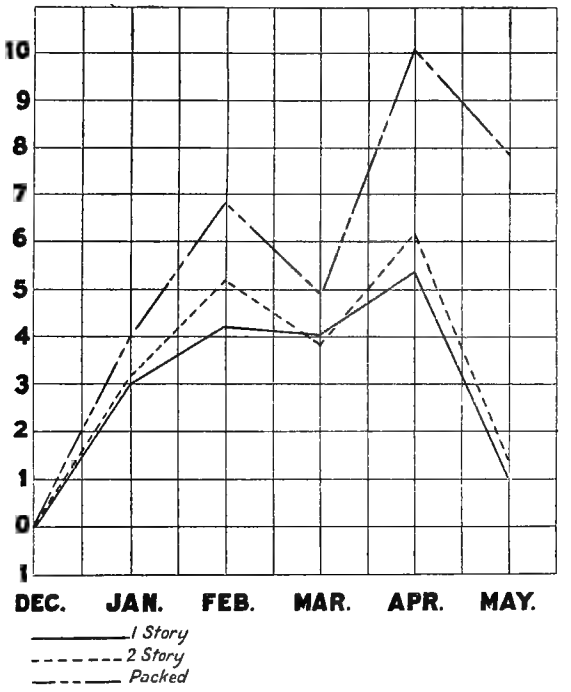

Fig. 3. A comparison of the amount of stores consumed each month by colonies in packed hives and the amount consumed by colonies in unpacked hives.

but the packed hive gained 24,844. When judged by the standard of the number of bees in the hive, packing appears to be the most valuable factor of wintering, excepting, of course, sufficient stores.

The Amount of Stores Necessary to Last a Colony Until the Beginning of the Honey-Flow

The amount of stores necessary to last a colony until the honey-flow begins will depend largely upon the size of the colony, size of the hive, and upon the amount of protection which it has.

Figure III represents, graphically, the amount of stores consumed by the bees in each kind of hive throughout the winter. As will be seen in an examination of this figure, the colonies in the one-story hive consumed less stores than any of the others, while the colonies in the packed hives consumed the most. This difference is especially noticeable during the month of March at which time the stores were being used for brood rearing. A comparison between Figure I and Figure III will show a direct relation between the amount of stores consumed and the number of bees present in each colony at the beginning of the honey-flow.

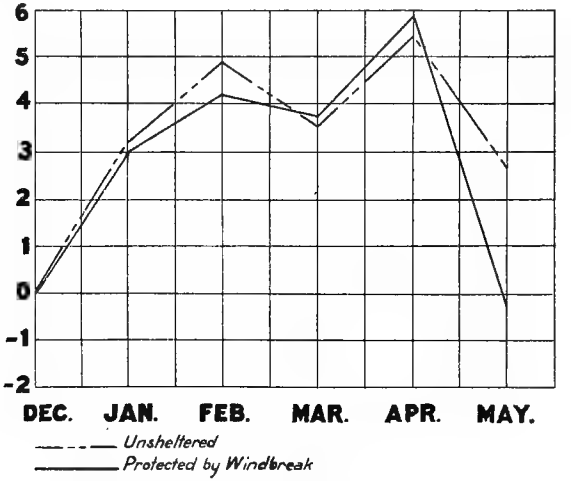

Fig. 4. A comparison of the number of pounds of stores consumed by colonies that are not sheltered with the amount consumed by colonies that are sheltered by a windbreak.

Figure IV represents a comparison of the amount of honey consumed by colonies wintered in the open, and those sheltered by a windbreak. The sheltered colonies consumed less during December, January, and February, but during March they used more than the unprotected colonies. During April they used less stores, or rather did not lose as much in weight, owing to the fact that brood rearing had continued for some time, and since it was greater in the sheltered colonies, the presence of the new bees, and what honey could be gathered at that time account for the fact that they gained weight during that month.

A study of this figure will show that during the months of December, January, and February, when stores were being consumed only to maintain the life of the bees that were already in the hive, those which were in sheltered positions did not consume as much honey as those in the open. However, during the month of March they consumed so much more honey than did the other colonies that the total amount consumed was about equal in both cases, the difference being that the colonies in the sheltered positions consumed their greater amount of stores for the purpose of brood rearing. Had weights been taken only at the beginning and end of these periods, the fact that the unsheltered hives consumed more at one time than the sheltered, and less at another, would not have been noticed.

TABLE III. MONTHLY CHANGE IN WEIGHTS

In the upper column for each month are placed those colonies protected by a windbreak and in the lower those not protected. Unless otherwise stated, the figures given represent a loss in pounds of weight.

One-story	*Two-story*	*Packed hive*
	December, 1918, to January, 1919	
2 6/8	3 2/8	3 4/8
3 2/8	3	4 2/8
	January, 1919, to February, 1919	
3 5/8	5 1/8	5 4/8
4 6/8	5 2/8	8 1/8
	February, 1919, to March, 1919	
4 1/8	3 4/8	5 4/8
3 7/8	3 3/8	4 3/8
	March, 1919, to April, 1919	
6 2/8	5 5/8	10 7/8
4 3/8	6 5/8	9 2/8
	April, 1919, to May, 1919	
4/8 gain	1/8 gain	4 1/8
2 5/8	2 5/8	11 5/8
	Total for 151 days	
16 2/8	17 3/8	24 4/8
18 7/8	20 7/8	37 5/8
	Average Daily Consumption	
1.6 oz.	1.8 oz.	2.6 oz.
2. oz.	2.2 oz.	3.9 oz.

Table III shows that the total amount of stores consumed for a period of 151 days was less for the one-story hive in the open, being 16 2/8 pounds, and greatest for the packed hive in the sheltered position. Reference to Figure I will show that the number of bees in the spring is proportional to the amount of stores consumed. The one-story unpacked hive lost 3,282 between fall and spring, while the packed hive gained 24,844. The difference between the sheltered and unsheltered colonies, as regards daily consumption, was 4/10 of an ounce for the one-story hives, 4/10 of an ounce for the two-story hives, and 1 3/10 ounces for the packed hives. It has been shown that less honey will be required to winter bees in a one-story hive than in either the two-story or packed hive; that less will be required in a two-story

hive than in the packed hive, and in each case less stores will be consumed where the bees are not protected by a windbreak than would be the case if they are protected, but the number of bees in the colony at the beginning of the honey-flow is directly proportionate to the amount of stores consumed by that colony during the winter.

The Effect of Climatic Conditions on Wintering

One of the arguments most commonly made against using winter protection is that the bees in some particular locality may not need any winter protection because that locality has such open winters.

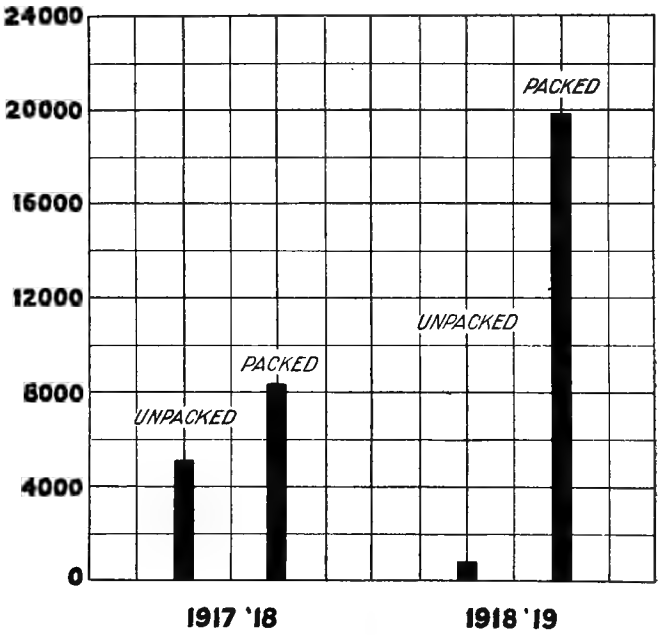

Fig. 5. Shows the average gain in number of bees in packed and unpacked hives during a severe winter with long periods of cold weather and the gain or loss in the same colonies during an open winter with shorter periods of cold weather.

Figure V represents, graphically, the effects of both a severe winter and an open winter upon the number of bees to be found in the colony in the spring. In the winter of 1917–18, which was very severe, bees were confined to their hives for long periods at a time, while the winter of 1918–19 was an open winter with no long periods of cold weather.

Figure V plainly shows which winter was the more favorable for the successful wintering of bees. During the severe winter of 1917–18, the one-story hive in the open lost 332, while during the open winter

of 1918–19 the same hive lost 3,282. During the severe winter, the two-story unprotected colony gained 2,808, while during the open winter this same colony lost 469. During the severe winter, the one-story colony, protected by a windbreak, gained 4,538, while in the open winter the same colony gained only 313. The two-story hive, protected by a windbreak, gained 13,346 bees during the severe winter, but only 5,936 during the open winter. However, the effect of climatic conditions is much more noticeable on the unpacked colonies than on the packed ones. The insulation which is placed around the hives protects the bees from any sudden changes of weather. If the warm sun beats upon unpacked colonies it soon causes a considerable rise in temperature within the hive. However, with a well insulated colony this would not be the case. Although the unpacked hives did not do as well during the open winter as they did during the severe winter, yet the packed hives did even better, owing to the fact, as explained before, that they were packed with leaves, which is a better insulating material than that which was used the previous winter. While one colony in the open was losing 3,282 bees, the packed hive in the open during this open winter gained 22,968, but in the windbreak, while the one-story unpacked hive gained 313, the packed hive gained 24,844.

The figure above, and the data which accompany it, plainly indicates that a severe winter, with long periods of cold weather, is really much more favorable than is the open winter with shorter periods of cold weather.

Form of Winter Protection Which Will Insure the Strongest Colony of Bees at the Beginning of the Honey-Flow

Reference to the figures given above would show that the two-story hive has advantages over the one-story hive, and also that probably for the same reason a large hive would be equally as good, if not better, than the two-story hive, and also that a well packed colony is greatly to be desired over an unpacked colony. The difference in the number of bees in the unpacked and packed hives is sufficiently great to more than repay the expense which a beekeeper may be put to in providing sufficient packing. In order to know the amount of stores to leave in the hive, the beekeeper must take into consideration the type of hive he is going to use. If it is a one-story to be used with no packing, he should leave at least 20 pounds of stores, as this would usually carry the bees through until the beginning of the honey-flow. However, 25 pounds would be a safer amount. If he is going to winter his bees in a two-story unprotected hive, then he had better leave 25 to 30 pounds, preferably 30 pounds. If, however, he is going to pack them he should leave enough stores to last well into the spring, as he will not need to

molest them during the early spring. For this reason he should leave 40 to 50 pounds. While ordinarily they would pass the winter well on 40 pounds, it would be better to have the 50 pounds in there for safety.

The value of a windbreak has been clearly shown, and as explained by Phillips and Demuth, this should consist of a broken windbreak, such as a hedge, or if a fence must be used, it should be so constructed that there will be large cracks between the boards. To sum up the whole thing: a packed hive sheltered from the wind by a good windbreak, having 45 or 50 pounds of stores, has the best chance of passing the winter successfully, and will probably contain the largest number of bees in the spring at the beginning of the honey-flow ready to take advantage of the same.

Summary

First. Directions have been given in previous publications as to the method for giving bees winter protection. The purpose of this work is to secure data showing the necessity of using this winter protection.

Second. Six hives containing a known amount of honey and a known number of bees were placed on scales, and daily readings taken of all changes in weight.

Third. Three of these hives were sheltered by a windbreak while the others were not.

Fourth. Each set of three consisted of one one-story hive, one two-story hive, and one packed hive.

Fifth. In addition to making daily readings of the changes in weights, a general weighing was made at the beginning of the honey-flow in the spring to determine the number of bees in the colonies on that date.

Sixth. These observations show that the two-story hive is preferable to the one-story hive, and the packed hive is much to be preferred over the unpacked hive.

Seventh. It was also shown that a windbreak is very essential, especially to colonies which have no other form of winter protection.

Eighth. The effect of a severe winter was found to be less injurious to the over-wintering of bees than an open winter.

Ninth. Colonies which are packed for the winter consume more stores, owing to the fact that more stores are necessary, due to increased brood rearing.

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VALUE OF WINTER PROTECTION FOR BEES[1]

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ABSTRACT

Previous work is briefly summarized. The data secured during the past four years are tabulated and show that a wind break made an average difference of 8,600 bees in a one story, unpacked hive, 7,968 in a two story, unpacked hive and 3,539 in a packed hive, indicating that packing will to a certain extent offset the disadvantage of a wind break. A packed hive in a wind break shows a decided advantage over unpacked hives.

The behavior of the honey bee during the winter season has been carefully studied by Phillips and Demuth[2] and it is not intended to present in this paper any new facts concerning behavior of bees during the winter season, but rather to give some specific figures on the results which beekeepers may expect by applying the facts given by these authors.

Regardless of how clear an explanation may be of the necessity for following any line of procedure, if it involves work or expense, there will always be a large number of people who will claim that either the practice is not necessary for their locality, or else that it is too expensive.

An experiment has been carried on at the Kansas State Agricultural Experiment Station to secure data on the value of winter protection for bees. Phillips and Demuth have plainly shown that a colony of bees, in order to winter successfully, must have: First, a large number of young bees; second, plenty of good stores well placed; third, protection from prevailing winds, and fourth, sufficient packing with some insulating material. Why these are needed is carefully explained, and it was the purpose of the Kansas experiment to show definitely the value of applying these principles.

The results of the first three years' work have been reported[3] in which it was explained that two series of hives were used in the experiment, one set of which was protected by a dense windbreak of shrubbery, while the other was placed in the open. In each set there were used one

[1]Contribution No. 83, from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project No. 126 of the Agricultural Experiment Station.

[2]Phillips, E. F., and Demuth, G. S.—Outdoor Wintering of Bees. U. S. D. A. Farm. Bul. 695, pp. 12, 1915.

Phillips, E. F., and Demuth, G. S.—The Preparation of Bees for Outdoor Wintering. U. S. D. A. Farm. Bul. 1012, pp. 20, 1918.

[3]Merrill, J. H.—Preliminary Notes on the Value of Winter Protection for Bees. Journ. Econ. Ento., Vol. 13, No. 1, 1920, pp. 99–111.

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one-story hive and one two-story hive, all of which were left unpacked. In addition to these there were in each set a two-story hive placed in a packing box and insulated with four inches of packing beneath, six inches on the side, and eight inches on top. Each colony was requeened in August with a young queen and all of the queens used each year were from the same mother. In the two sets of hives—both the packed and unpacked—it was planned to leave sufficient stores to carry the colonies through until the honey flow began. In other words, it was attempted to have conditions in all of the colonies as nearly similar as possible in the fall of the year.

As a standard of what constituted good wintering, it was agreed that those colonies which possessed the greatest number of bees at the beginning of the honey flow were those which had wintered the best. In the fall of the year, and again in the spring, the number of bees in each hive was determined by a system of weighing in which a pound represented 5000 bees.

The results of the first two years' work with this experiment were published in the first paper. The results of the third years' work appeared in the second paper on this subject. As all of the results of this experiment have a similar trend, the data secured from the fourth years' work, which have not been published, will be averaged with the data secured from the first three years' observations.

Table 1 presents an average of the data secured in the four years during which this experiment was conducted.

TABLE NO. 1.—AVERAGE WINTER GAIN OR LOSS FOR FOUR YEARS

Date	No Windbreak			Windbreak		
	No. 2 1-story Unpacked	No. 16 2-story Unpacked	No. 4 2-story Packed	No. 5 1-story Unpacked	No. 6 2-story Unpacked	No. 7 2-story Packed
1917–1918	-332	2,808	4,566	4,538	13,346	15,132
1918–1919	-3,282	469	22,968	313	5,936	24,844
1919–1920	625	-1,250	5,625	10,000	8,125	3,800
1920–1921	-25,358	-1,525	*	-8,800	4,029	47,575
Average gain or Loss	-7,087	-109	11,053	1,513	7,859	22,838

*Hive number four was blown over by the wind during the winter of 1920–1921, and was eliminated that year.

Where the result indicated is preceded by a minus sign, it signifies that there were fewer bees in the hive when it was weighed in the spring than in the fall. Where the result stated is a positive number, it indicates that there were more bees in that hive in the spring than in the fall. It will be noticed that during the winter of 1919–1920, neither

hive No. 16 nor hive No. 7 had as many bees as might have been expected.

Since it was the purpose of this experiment to ascertain the best methods of wintering, the failure of these two hives should be explained. The explanation is simple—they both lacked sufficient stores. On April 19th, the stores in colony No. 7 were practically exhausted. While this was indeed unfortunate for those individual colonies, it was fortunate for the experiment as a whole. Colony No. 7 had only an increase of 3,800 bees; whereas, had it had sufficient stores, the number might have been about ten times as many. The same condition applies to colony No. 16. Sufficient stores were left in all of these hives to amply supply their needs through an ordinary winter and spring. However, a severe freeze on Easter Sunday killed all of the fruit bloom; consequently, more honey was needed. An examination of the two colonies which were deficient in stores showed much less brood than any of the others, which would indicate that if the stores in a hive were nearing exhaustion, the daily rate of egg-laying would be materially lowered. This emphasizes the necessity for leaving plenty of stores.

The most marked results on the value of winter protection were those obtained during the winter of 1920–1921, which was very mild and open with frequent opportunities for the bees to take flight. In fact, it was very similar to winters in those parts of the country where the remark is often heard that "there is no need of packing our bees because we have such mild, open winters." Colony No. 7, which was not only packed but protected by a windbreak, had 47,575 more bees in the spring than it had in the fall, while the one-story unpacked hive in the open had 25,358 less bees in the same year, which would seem to answer the above quoted objection. A study of the results noted in Table II indicates that a windbreak is of much greater importance than is ordinarily believed.

TABLE II—VALUE OF WINDBREAKS

	No. 5 1-story unpacked	No. 6 2-story unpacked	No. 7 2-story packed
Protected by windbreak	1513	7859	*14,592
	No. 2	No. 16	No. 4
Unprotected by windbreak	7087	−109	*11,053
Advantage of windbreak in number of bees	8,600	7,968	3,539

*Colony No. 4 was blown over by the wind during the winter of 1920–1921 and was eliminated from the experiment for that year. It was during that year that colony No. 7 showed the greatest supreiority over unpacked hives; therefore, it seems reasonable to infer that colony No. 4 would likewise have shown a marked superiority, but as No. 4 was eliminated by accident, No. 7 should be eliminated during that year as well, hence, this table shows an average of three years' work instead of four.

The data recorded in this table show that the one-story hive in the windbreak had an average advantage over the one-story hive in the open of 8,600 bees. The two-story, protected hive had 7,968 more bees, while the packed hive in the windbreak, for a three-year average, had the advantage of 3,539 bees over the unprotected, packed hive. When it is not possible to have a windbreak, good packing will, to a certain extent, overcome this disadvantage. A dense mass of shrubbery protected the bees on the north, west, and south sides, while the east side was protected by a grove of trees. A study of Table III will show the marked advantage of packed over unpacked hives.

TABLE III.—VALUE OF PACKING

	Windbreak		No Windbreak	
	1-story	2-story	1-story	2-story
Packed	22,838	22,838	11,053	11,053
Unpacked	1,513	7,859	−7,087	−109
Four year average difference	21,325	14,979	18,140	11,162

The packed hive in the windbreak had an average of 21,325 more bees than the one-story hive, and 14,979 more than the two-story hive. In those hives unprotected by a windbreak, the difference in numbers is not quite so marked, yet there is a wide margin, as the packed hive had an average of 18,140 more bees than the one-story hive, and 11,162 more bees than the two-story hive.

Since there are about 5,000 bees to a pound, and as they are worth $2.00 a pound at present, it will be seen that beekeepers may incur considerable expense for packing and still be the gainers. Furthermore, the beekeepers will have the advantage of having these bees in their own hives at the right time of the year, which might not be the case if they were obliged to depend on strengthening their colonies with package bees.

TABLE IV.—VALUE OF SUFFICIENT ROOM IN THE HIVE

	Windbreak	No Windbreak
2-story	7,859	−109
1-story	1,513	−7087
Four year Average Difference	6,346	6,978

When the one and two-story unpacked hives are compared, it will be seen that the two-story hive has an average advantage of 6,978 bees. When the similar hives, protected by a windbreak, are compared, the two-story hive will be found to have 6,343 more bees than the one-story hive. This difference is due to the fact that when the two-story hives are used it is possible to leave more stores, have them better arranged, and at the same time provide sufficient room for spring brood rearing. Judging from these facts, it would appear that if these conditions could

be met in a single hive body which would have the added advantage of having only one set of combs, the bees ought to winter better even than in the two-story hives. Some of the larger hives now in use should meet these requirements.

Summary

1. The purpose of this experiment was to show, by specific figures, the results obtained by applying the best known methods for wintering bees.

2. Six hives containing a known amount of honey and a known number of bees were placed on scales, and daily readings taken of all changes in weight.

3. Three of these hives were sheltered by a windbreak, while the others were not.

4. Each set of three consisted of one one-story hive, one two-story hive, and one packed hive.

5. In addition to making daily readings of the changes in weights, a general weighing was made at the beginning of the honey flow in the spring to determine the number of bees in the colonies on that date.

6. It was shown that a two-story hive, unprotected, averaged 6,346 more bees than a one-story hive similarly placed, and that in the windbreak the two-story hive averaged 6,978 more bees than the one-story hive.

7. It was shown that the windbreak made an average difference of 8,600 bees in a one-story, unpacked hive, 7,968 in a two-story, unpacked hive, and 3,539 in a packed hive.

8. It is indicated that if a windbreak is not available, added packing will, to a certain extent, offset this disadvantage.

9. It was shown that unless sufficient stores are left in the hive, the queen will not lay eggs to her fullest capacity.

10. It was shown that the packed hive in the windbreak has an average advantage of 21,325 more bees than the one-story, unpacked hive, and 14,979 more bees than the two-story, unpacked hive. Where there was no windbreak, the packed hive had an average advantage of 18,140 more bees than the one-story, unpacked hive, and 11,162 more bees than the two-story, unpacked hive.

MR. GREEN: Something was said in regard to the opportunity to fly during the winter. Provided they have an abundance of supplies and